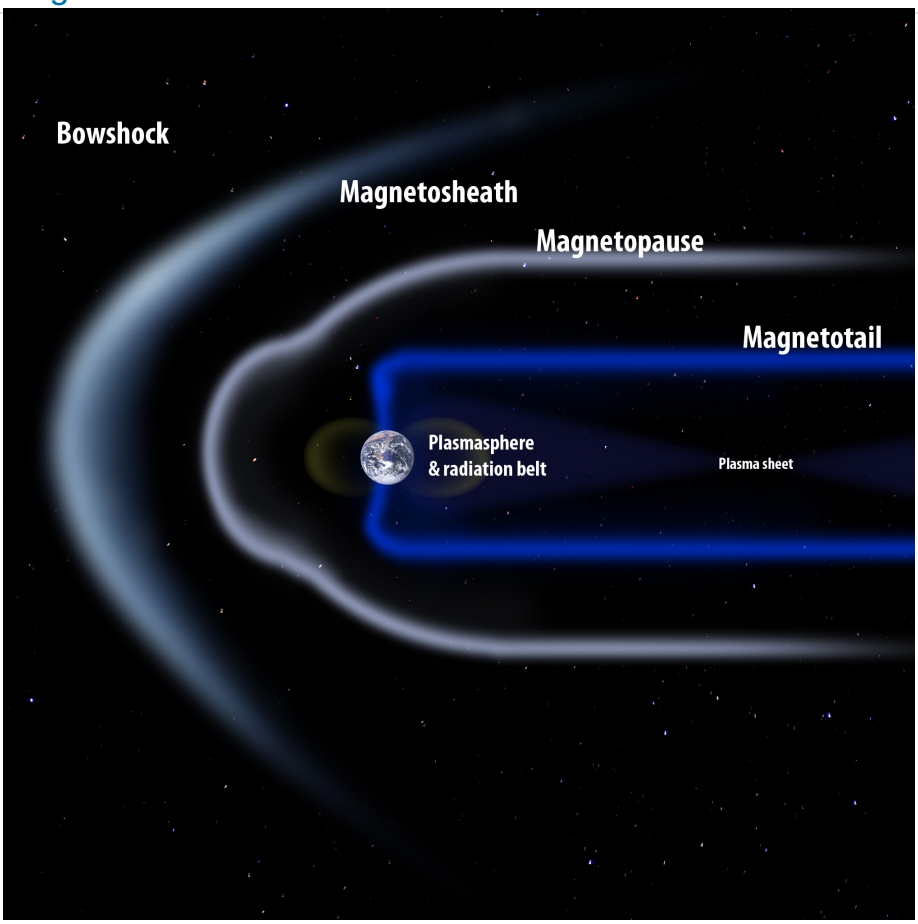
# 9.3: Origin of Magnetic Fields




Only two terrestrial planets, Earth and Mercury have strong magnetospheres.

https://commons.wikimedia.org/wiki/F...gnetopause.jpg

Since motions of charged particles create magnetic fields, a world can have a magnetic field if charged particles are moving inside. To generate a magnetic field, a planet must meet three requirements: 1) A molten, electrically conducting interior; 2) Convection in the interior and 3) A moderately rapid rotation.

Of the four terrestrial planets, Earth has the strongest magnetic field. Geologists believe that Earth's rotating molten core produces a **dynamo effect** that in turn, generates its magnetic field. Earth's core comprises about 33% of the planet's mass. As noted in the previous section, the core is molten because of the heat leftover from its formation and the presence of radioactive isotopes.

After Earth, Mercury has the second strongest magnetic field. It is also the most metallic and its core makes up about 60% of its mass, giving it the largest ratio of a planet's core to its size in the Solar system. However, Mercury is also the smallest planet and therefore has the highest surface area to mass ratio. As a result, its core likely lost most of the heat from its formation. The presence of a relatively strong magnetic field raises the question as to whether it is still molten despite losing most of its heat of formation. One hypothesis posits that the core contains sulfur, which would lower the melting point of the iron core. Another possibility is that Mercury's magnetic field is somehow produced by charged particles from the solar wind.

Venus is close to the Earth in size but does not have a strong magnetic field. This has puzzled planetary scientists. The lack of plate tectonics on Venus may indicate a lack of convective forces in the mantle. This would indicate that is core may not be molten. Also, its slow rotation may not be sufficient to generate a dynamo.

In contrast, Mars has a rotation period that is close to the Earth's. Data indicates it has an iron core about half the planet's radius in size. Like Venus, however, Mars lacks any convective currents in its interior. Data from the oldest rocks indicate that Mars once did have a strong magnetic field. So, what could have shut it down? Mars' small size might have caused the core to cool down and

solidify. Also, there might be hydrogen in the core, which could shut down convection. The Mars InSight lander landed on Mars on November 26, 2018 to explore the interior and may answer some of these questions.